DIRECT TESTIMONY OF
R. NICHOLAS WINTERMANTEL
ON BEHALF OF
DOMINION ENERGY SOUTH CAROLINA, INC.
DOCKET NO. 2023-9-E

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is R. Nicholas ("Nick") Wintermantel and my business address is 3000 Riverchase Galleria, Hoover, AL, 35224.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am a Principal at Astrapé Consulting. Astrapé is a consulting firm that provides expertise in resource planning and resource adequacy to utilities across the United States and internationally.

Q. DESCRIBE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I graduated summa cum laude with a Bachelor of Science in Mechanical Engineering from the University of Alabama in 2003. I also obtained a Master's degree in Business Administration from the University of Alabama at Birmingham in 2007. I have worked in utility planning for over 20 years. I started my career at Southern Company where I worked in various roles within Southern Company. In my various roles, I was responsible for performing production cost simulations, financial modeling on wholesale power contracts, general integrated resource planning, and asset management. In 2009, I joined Astrapé as a Principal Consultant and have been responsible for resource adequacy and Effective Load Carrying Capability ("ELCC") studies across the U.S. and internationally.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA ("COMMISSION")?

A. Yes. I have testified before the Commission in several other proceedings.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My testimony introduces and summarizes the DESC 2023 Planning Reserve Margin Study ("the Study") that Astrapé recently conducted on behalf of the Company and was filed as part of the 2023 Integrated Resource Plan ("IRP"). The study is attached as Exhibit __(RNW-1).

Q. PLEASE PROVIDE A SUMMARY OF YOUR AND YOUR FIRM'S EXPERTISE PERFORMING PLANNING RESERVE MARGIN STUDIES.

A. I joined Astrapé Consulting in 2009 and have managed planning reserve margin studies for utilities and system operators across the U.S. and internationally. These studies have used Astrapé's Strategic Energy & Risk Valuation Model ("SERVM"). In the Southeast, Astrapé has performed studies for utilities including Duke Energy Carolinas, Duke Energy Progress, Tennessee Valley Authority, Entergy, Southern Company, Central Louisiana Electric Co-op, Georgia System Operations Corporation, Louisville Gas & Electric, and Santee Cooper. Outside of the Southeast, Astrapé has used SERVM to perform planning reserve margin studies for large independent operators such as the Southwest Power Pool ("SPP"), Electric Reliability Council of Texas ("ERCOT"), the Midwest Independent System Operator ("MISO"), and Alberta Electric System Operator ("AESO"). For many of these entities, I have managed ELCC studies for solar and storage like the study my team performed for DESC.

Q. PLEASE SUMMARIZE THE DESC 2023 PLANNING RESERVE MARGIN STUDY THAT YOU PERFORMED FOR THE COMPANY

A. The DESC 2023 Planning Reserve Margin Study determines the planning reserve margin necessary for the DESC system to meet a 1 day in 10-year reliability standard which is common practice in the utility industry. In doing so, we also assessed the ELCC for solar and battery storage resources on DESC's system.

Q. PLEASE FURTHER DEFINE THE 1 DAY IN 10-YEAR RELIABILITY STANDARD THAT WAS USED IN THE STUDY TO SET RESERVE MARGIN REQUIREMENTS.

A. Loss of Load Expectation ("LOLE") represents the expected number of days in a year when the utility will not have enough resources to meet its load. The 1 day in 10-year reliability standard is met when the utility has enough capacity installed so that firm load shed is expected to occur only 1 day in 10 years. The 1 day in 10-year LOLE standard equates to 0.1 days/year. A reserve margin study computes the capacity required to meet this standard. We then convert that capacity to a reported planning reserve margin which is the excess installed capacity above the forecasted peak demand expressed as a percentage of peak demand, in this case 20.1%.

Q. PLEASE DESCRIBE THE KEY REASONS A UTILITY NEEDS TO CARRY AN ADEQUATE PLANNING RESERVE MARGIN.

A. Customers expect to have electricity available to them on demand and at all times of the year, especially during extreme weather conditions when electricity is needed for heating and cooling. Most peak periods for the DESC system occur during cold winter periods when families are at home preparing for their day or just after their workday when they are cooking and beginning evening activities.

While a utility plans for the normal weather forecasted load, the actual load can be lower or higher than the forecast due to extreme weather or economic conditions that exceed those used in the load forecast. Additionally, generators do not provide perfect capacity in all hours of the year due to planned and forced outages, intermittency, and energy limitations. A planning reserve margin helps to mitigate the risk of not being able to serve customers by accounting for these uncertainties. An appropriately calculated planning reserve margin allows a utility to withstand unexpected conditions such as severe weather, unexpected load growth, or significant generator outages in order to maintain the 1 day in 10-year reliability standard.

Q. IN YOUR RESERVE MARGIN STUDY, HOW WAS THE MODEL FRAMEWORK SETUP TO ENSURE THE UNCERTAINTY AROUND THESE KEY COMPONENTS WAS APPROPRIATELY CAPTURED?

A. Astrapé used the SERVM model to perform tens of thousands of hourly simulations for the 2026 study year at various reserve margin levels. Each of the yearly simulations was developed through a combination of deterministic and stochastic modeling of the uncertainty of weather, economic growth, unit performance, and neighbor assistance.

For this analysis, a combination of forty-two weather years were simulated with five economic load forecast error multipliers and eighty unit outage draws for each load scenario designed resulting in 16,800 hourly simulations at each reserve margin level simulated. Each of the results from these hourly simulations was probability weighted based on their probability of occurrence. This produced a weighted average LOLE for each potential reserve margin which ultimately showed that the planning reserve margin required to meet the 0.1 LOLE standard was a winter reserve margin of 20.1%. A winter reserve margin lower than that would result in a higher LOLE than the target (*i.e.*, a higher probability of customer outages), and a higher reserve margin would result in a LOLE that is less than the target.

Q. HOW WAS ASSISTANCE FROM NEIGHBORING BALANCING AREAS INCORPORATED IN THE STUDY?

A. Loads and resources for DESC and surrounding first tier balancing areas were modeled in the Study. The model simulates the historical weather diversity the DESC system and its neighbors have experienced. Forty-two unique weather years were modeled for DESC and its neighbors. SERVM also captures generator outage diversity in neighboring balancing areas across the simulations because forced outages at neighboring generators were randomized using Monte Carlo draws. When modeling neighboring regions, SERVM allows regions to share capacity based on economics, generator availability, and transmission constraints.

Q. PLEASE DESCRIBE ANY SENSITIVITIES PERFORMED AROUND THE BASE CASE AND SUMMARIZE THOSE RESULTS.

A. The Base Case which includes neighboring assistance as discussed above results in calculating a planning reserve margin of 20.1% to meet the 1 day in 10-year standard. There were four sensitivities performed in addition to the Base Case:

1) **Island Case-** In the islanded case, DESC's electrical system was modeled as an island without any access to neighbor assistance. This sensitivity calculated that a planning reserve margin of 43% would be needed to meet the 1 day in 10-year standard without the possibility of any assistance from neighboring utilities.

2) **Island Case Optimized Planned Maintenance-** DESC's system was modeled as an island without any access to neighbor assistance but SERVM was

provided with perfect knowledge of each simulations' load shape in order to optimally plan each units scheduled planned maintenance. This sensitivity results in a planning reserve margin of 37.0% in order to meet the 1 day in 10-year standard which shows that even with optimally planned scheduled maintenance neighbor assistance is still quite valuable across the entire year.

3) **Low Cold Weather Load Response-** This sensitivity was performed in addition to the High Cold Weather Load Response to provide bookend reserve margins to assess the impact of the assumed cold weather load response assumptions on the planning reserve margin. The DESC loads in this sensitivity were held artificially low by redeveloping them in such a way that they were never allowed to exceed the highest load seen in the five years of historical data used to train the load neural networks. So, while cold events still occurred in the simulations as they were seen in history, the peak loads were capped at the highest load seen in the last five years. This sensitivity shows that even with load response limited to loads experienced in recent history, a 16.2% reserve margin is required. This sensitivity represents an extreme bookend on load response because it is not likely that loads will saturate at the lowest temperature seen in the last 5 years.[1]

4) **High Cold Weather Load Response-** This sensitivity assumes an increased load response in times of extreme cold weather similar to the 30% load

[1] For reference, the lowest system temperature in the last 5 years of modeling is 15 degrees Fahrenheit while the lowest temperature seen in the 1980 – 2021 record is 3 degrees Fahrenheit. This low cold weather low response sensitivity assumes no additional load response between 15 and 3 degrees Fahrenheit.

variance ERCOT experienced in February of 2021 during Winter Storm Uri compared to their weather normal forecast. The load shapes used in the simulations were redeveloped so that the maximum peak load variance due to extreme cold weather seen for DESC reached 30%. Much like the Low Cold Weather Load Response Sensitivity, this sensitivity represents a bookend and shows that if load response was higher than what was included in the Base Case and in line with what ERCOT saw in 2021 during record temps that a planning reserve margin of 22.2% would be required to meet the 1 day in 10-year standard.

Solar and Storage ELCC Results

Q. WHAT IS MEANT BY THE ELCC OF A RESOURCE?

A. ELCC refers to the amount of dependable capacity that can be counted on from a resource for resource adequacy purposes. The ELCC is determined by finding the amount of additional load that can be served by the resource while maintaining the same system reliability as compared to a system without the resource.

Q. PLEASE DESCRIBE WHY IT IS IMPORTANT TO UNDERSTAND THE ELCC OF INTERMITTENT RESOURCES SUCH AS SOLAR AND ENERGY LIMITED RESOURCES SUCH AS BATTERY STORAGE.

A. As the penetration of energy limited resources of solar and battery storage continues to increase on the DESC system, it is important for planners to accurately understand the resources' reliability contributions especially during critical hours when capacity resources are needed the most. Solar is a variable energy resource that can't produce its maximum capacity in many hours of the day and battery storage is an energy limited resource. For these reasons, additional ELCC analysis is required.

Q. HOW DID DESC AND ASTRAPÉ ENSURE THAT FUTURE THERMAL RESOURCES WERE COMPARED EQUITABLY WITH SOLAR AND BATTERY STORAGE RESOURCES SINCE ELCC VALUES WERE NOT CALCULATED FOR THERMAL RESOURCES?

A. Thermal resources are fully dispatchable resources but are not perfect due to forced outages and planned maintenance. In order to ensure solar and battery storage resources were compared equitably with new thermal resources, the load carrying capability for the solar and storage ELCC calculations were measured assuming the load added was not perfect and had a 4% outage rate. This 4% outage rate represents the expected outage rate of a new thermal resource. So, in other words, storage and solar resources were not compared against a perfect resource but instead against a resource with an outage rate. Any differences in assumed ELCC between these resource classes and thermal resources are primarily due to intermittency for solar and energy limitations for battery storage.

Q. PLEASE SUMMARIZE THE SOLAR ELCC RESULTS OF THE STUDY.

A. The table below summarizes the average winter solar ELCC values by incremental MW tranche. Because the critical hours are during winter mornings before or just after sunrise, the ELCC value of solar resources is limited.

Table 1. Average Winter Solar ELCC Values

Incremental Solar (MW)	Solar Average ELCC (%)
100	2.70%
600	0.70%
1,100	0.50%
1,600	0.50%

Q. PLEASE SUMMARIZE THE STORAGE ELCC RESULTS EXPLAINING THE DIFFERENCE BETWEEN THE TWO SETS OF RESULTS PROVIDED IN THE STUDY.

A. The table below provides the marginal and average winter ELCC values for four incremental storage tranches assuming two potential different modes of operation of future DESC storage. The "Conservative Operations on Extreme Days" analysis assumes that DESC would have full control of the operation of the storage resource(s) and thus could primarily conserve the storage energy and dispatch it only to address reliability issues on extreme days. The "Assumes Economic Arbitrage" analysis assumes that DESC would not have full control of the operation of the storage resource(s) and that the storage resource would be primarily dispatched to take advantage of energy arbitrage. As shown in the results tables below, the "Assumes Economic Arbitrage" analysis results in a lower ELCC.

This is expected given their dispatch patterns would result in the occasional scenario where there are unexpected forced outages on the DESC fleet and the storage resource(s) would be unavailable as they have already been dispatched to take advantage of energy arbitrage. The average ELCC refers to the ELCC of the entire tranche of battery storage while the marginal ELCC refers to the value of the next MW of storage. For example, 800 MW of storage assuming economic arbitrage has an average ELCC of 86% but the next MW (801st MW) has a value of 80%.

Table 2. Storage ELCC Values

Incremental Storage (MW)	4 Hour Storage Average ELCC (%)	4 Hour Storage Average ELCC (%)	4 Hour Storage Marginal ELCC (%)	4 Hour Storage Marginal ELCC (%)
	Conservative Operations on Extreme Days	Assumes Economic Arbitrage	Conservative Operations on Extreme Days	Assumes Economic Arbitrage
50	100%	93%	100%	93%
300	100%	91%	100%	90%
550	99.00%	88%	98%	85%
800	94.80%	86%	88%	80%

Q. WHAT ARE THE KEY CONCLUSIONS OF THE 2023 DESC PLANNING RESERVE MARGIN STUDY?

A. The key conclusions of the study are that based on the simulation results, a 20.1% winter reserve margin meets the 1 day in 10-year standard and is appropriate for DESC planning purpose as a primary requirement. Even though there is uncertainty surrounding the extreme cold weather load response, allowing the winter reserve margin to drop below 20% is likely to provide reliability levels lower than DESC's 1 day in 10-year reliability standard. Additionally, based on the analysis of the summer LOLE shown in the study, it can also be concluded that a summer reserve margin requirement of 15% is sufficient. Thus, DESC should continue to monitor and observe summer risks, but if a 20.1% winter reserve margin is maintained it is expected that this 15% requirement will be automatically met. Regarding winter ELCCs, initial tranches of battery storage have a relatively high ELCC but decline as penetrations increase. Due to timing of resource adequacy risks occurring on cold winter mornings, solar resources have low ELCC values.

Q. THE FOLLOWING WAS ORDERED BY THE SOUTH CAROLINA COMMISSION:

"THE COMMISSION EXPECTS THAT RELIABILITY AND RESILIENCY CONSIDERATIONS MUST BE PRESENTED AND SUCH PRESENTATION MUST INCORPORATE DETAILED DISCUSSION OF THE RESERVE REQUIREMENTS NEEDED BY THE UTILITY, INCLUDING A TRADITIONAL LOSS OF LOAD STUDY"

HOW DOES THE 2023 DESC PLANNING RESERVE MARGIN STUDY MEET THOSE REQUIREMENTS?

A. The 2023 DESC Planning Reserve Margin Study is a loss of load study and determines the probability that load will be shed at different reserve margin levels. The study uses best practices in analyzing extreme weather, load forecast error, unit performance, and market assistance and results in a recommended planning reserve margin to meet the 1 day in 10-year reliability standard.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.